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Analysis and Design of Castellated Beam using ANSYS

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Abstract: Castellated beam is the steel structure which are made by flame cutting rolled beam along with centreline than rejoining two halves by the welding so that overall depth increase by 1.5% for improved structural strength of using same quantity of material. The beam is a flexural member than maximum bending moment in middle portion and shear for maximum occurs at support, in castellated beam hole are made in the web portion with different shape, the surface of hole in inner side shear stress are induced due to shear force which are may cause to failure of beam or its start to fail from hole we produce by cutting, so reduce the shear stress we have to closed the cutting hole by refilling of same material up to specified span of beam. in this paper we have to we have to analysis of different shape of beam with refilling/close the castellated hole from both side of support. The study and analysis based on two parameter, first we have to analyse regular castellated beam in software and second parameter is to closed the hole of beam and analysis with same software and compare both the result which are obtain from beam.

Keywords: Castellated beam, shear zone, critical section, economical, castellated hole, ANSYS.

I. INTRODUCTION

Engineering are trying to make the structure economical and more safer to all the failure condition this beam is one of the example of that. And continuous investigation and method is use to improve the strength and serviceability of Castellated beam. Which is made of flame cutting of I-section through its center line in zig zag pattern after cutting we rejoining the halves of beam to produce the shape of opening in the web of beam, generally Hexagonal, Square, Rectangular, Circular shape are used. This type of beam are more prefer for industrial building and now a day also used for small steel structure like Car parking, indoor stadium, foot over bridges etc. The depth of beam increase by 50% of its original depth, in design of structural element there depth is play vital role for its serviceability and safety. Its main advantage is that depth of beam increase without the increase the amount of steel which are make its cheap and light. other advantage of it that easy to assemble at site due to its light weight, good aesthetic view, its use as a duct for supply the fire pipe, electric pipe, AC pipe etc.

II. OBJECTIVE

- A. To increase the depths of beam without increase the amount of steel.
- B. To reduce the cost of structure for the same building using these beam.
- C. Make the structure economical.
- D. Handling and installation of this type of structural element are easier due to its light weight.
- E. It's also gives the good aesthetics view as compare to cellular beam.
- F. provide the pipe line for fire, electricity, AC duct etc
- G. Easy to assemble at site, painting, low maintenance etc.

III. MODEL DESCRIPTION

Two opening type of model has be Analysis by ANSYS software

- A. Castellated beam with Rectangular opening
 - B. Castellated beam with Circular opening
- In this paper deal with the six model of castellated beam.
- 1) Rectangular castellated beam Without hole close.
 - 2) Rectangular castellated beam With 1hole close.
 - 3) Rectangular castellated beam With 2hole close.
 - 4) Circular castellated beam Without hole close.
 - 5) Circular castellated beam With 1hole close.
 - 6) Circular castellated beam With 2 hole close.

Width of flange= $B_f=100$ mm
 Thickness of flange= $T_f=10$ mm
 Thickness of web= $T_w=7.6$ mm
 Height of section= $H=300$ mm
 Length of section = 6000mm

IV. ANALYSIS AND RESULT

1) Case-1 Castellated beam with rectangular opening

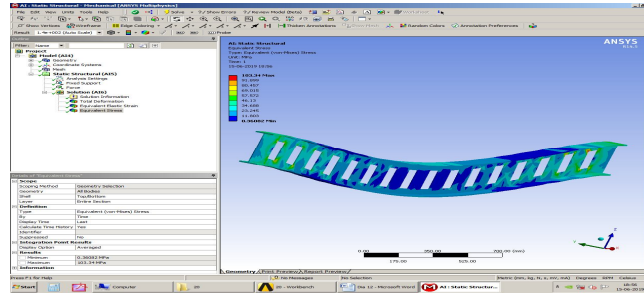


Figure. Castellated beam with rectangular opening

| Load | Deflection | stress |
|------|------------|---------|
| 10 | 0.4705 | 25.8355 |
| 20 | 0.941 | 51.671 |
| 30 | 1.4116 | 77.506 |
| 40 | 1.8821 | 103.342 |
| 50 | 2.3526 | 129.177 |
| 60 | 2.8232 | 155.013 |
| 70 | 3.293 | 180.848 |
| 80 | 3.764 | 206.684 |
| 90 | 4.234 | 232.519 |
| 100 | 4.7053 | 258.355 |

Table 4. rectangular opening without hole closing

2) Case-2 Rectangular beam with 1 hole close from both side of support.

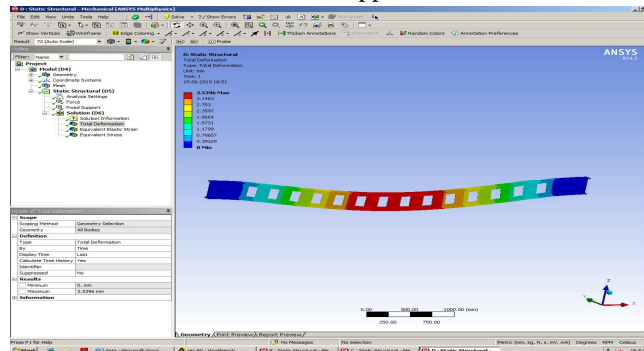


Figure. Rectangular with 1 hole close from both side of support.

| Load (KN) | Deflection (mm) | Stress (N/mm ²) |
|-----------|-----------------|-----------------------------|
| 10 | 0.4424 | 18.2965 |
| 20 | 0.8849 | 36.593 |
| 30 | 1.327 | 54.8895 |
| 40 | 1.7698 | 73.186 |

| | | |
|-----|--------|----------|
| 50 | 2.2122 | 91.4825 |
| 60 | 2.6547 | 109.779 |
| 70 | 3.0971 | 128.0755 |
| 80 | 3.5396 | 146.372 |
| 90 | 3.982 | 164.6685 |
| 100 | 4.4245 | 182.96 |

Table. One hole close near support of rectangular beam

3) Case-3 Two hole close near support of rectangular opening

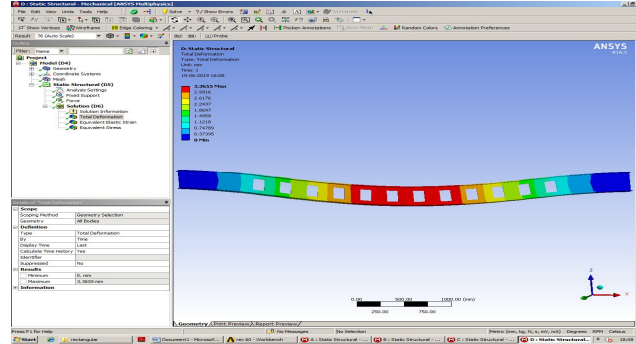


Figure 6. Two hole close near support

| Load (KN) | Deflection (MM) | Stress (N/mm2) |
|-----------|-----------------|----------------|
| 10 | 0.4206 | 15.968 |
| 20 | 0.8413 | 31.924 |
| 30 | 1.2619 | 47.889 |
| 40 | 1.6826 | 63.865 |
| 50 | 2.1032 | 79.854 |
| 60 | 2.5239 | 95.768 |
| 70 | 2.9445 | 111.723 |
| 80 | 3.3652 | 127.689 |
| 90 | 3.7859 | 143.64 |
| 100 | 4.2065 | 159.689 |

Table 6. Two hole close near opening

4) Case-10 castellated beam with circle opening.

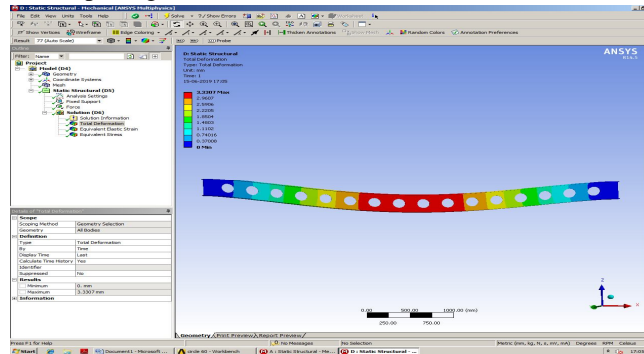


Figure. Castellated beam with circle opening.

| Load (KN) | Deflection(MM) | Stress(N/mm2) |
|-----------|----------------|---------------|
| 10 | 0.4163 | 18.325 |

| | | |
|-----|--------|---------|
| 20 | 0.8326 | 36.65 |
| 30 | 1.249 | 54.975 |
| 40 | 1.6657 | 73.352 |
| 50 | 2.0817 | 91.615 |
| 60 | 2.498 | 109.976 |
| 70 | 2.9143 | 128.275 |
| 80 | 3.3307 | 146.65 |
| 90 | 3.747 | 164.925 |
| 100 | 4.1634 | 183.25 |

Table. Castellated beam with circle opening.

5) Case-11 Circle opening with 1 hole close both side of beam

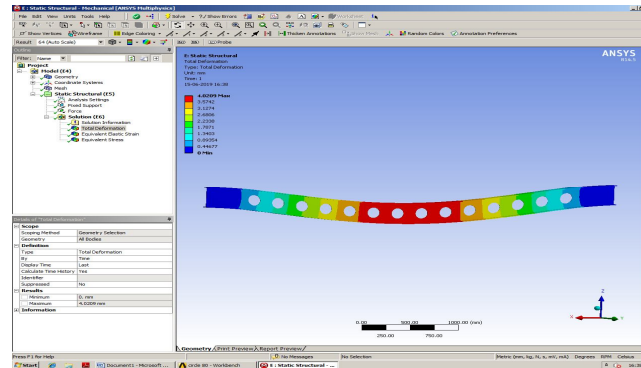


Figure. Circle opening with 1 hole close both side of beam.

| Load (KN) | Deflection(mm) | Stress(N/mm2) |
|-----------|----------------|---------------|
| 10 | 0.4021 | 14.543 |
| 20 | 0.8042 | 29.08 |
| 30 | 1.2063 | 43.623 |
| 40 | 1.6084 | 58.186 |
| 50 | 2.0105 | 72.754 |
| 60 | 2.4126 | 87.245 |
| 70 | 2.8147 | 101.734 |
| 80 | 3.2168 | 116.324 |
| 90 | 3.6189 | 130.867 |
| 100 | 4.021 | 145.654 |

Table. Circle opening with 1 hole close both side of beam.

6) Case-12 Circle opening with 2 hole close both side of beam.

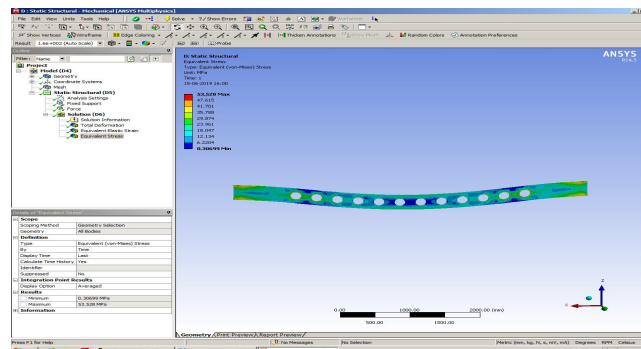


Figure. Circle opening with 2 hole close both side of beam.

| Load(KN) | Deflection(mm) | Stress(N/mm2) |
|----------|----------------|---------------|
| 10 | 0.39 | 13.382 |
| 20 | 0.7818 | 26.764 |
| 30 | 1.1727 | 40.146 |
| 40 | 1.5636 | 53.528 |
| 50 | 1.9545 | 66.913 |
| 60 | 2.3454 | 80.292 |
| 70 | 2.7363 | 93.67 |
| 80 | 3.1272 | 107.056 |
| 90 | 3.5181 | 120.438 |
| 100 | 3.909 | 133.82 |

Table 12. Circle opening with 2 hole close both side of beam.

V. RESULT AND DISCUSSION

Best or economical castellated beam with there opening shape.

1) Castellated beam with Rectangular opening.

| Load | 2 hole closed | | 1 closed hole | | Without hole closed | |
|--------|---------------|--------------|---------------|--------------|---------------------|--------------|
| | Deflection mm | Stress N/mm2 | Deflection mm | Stress N/mm2 | Deflection mm | Stress N/mm2 |
| 100 KN | 4.2065 | 159.689 | 4.4245 | 182.96 | 4.7053 | 258.355 |

2) Castellated beam with Circular opening.

| Load | 2 hole closed | | 1 closed hole | | Without hole closed | |
|--------|---------------|--------------|---------------|--------------|---------------------|--------------|
| | Deflection mm | Stress N/mm2 | Deflection mm | Stress N/mm2 | Deflection mm | Stress N/mm2 |
| 100 KN | 3.909 | 133.823 | 4.021 | 145.654 | 4.1634 | 183.25 |

VI. CONCLUSIONS

Objective of this paper was reduce the stress at surface of castellated hole with the close the hole of shear zone of beam to avoid the shear failure of beam, we also observe that in result deflection of beam remains same or less with compare to without close the hole. The main reason to reduce the stress of beam by closing the castellated hole at support is that improve the bearing capacity of beam with same span and same size of hole. If we consider the rectangular opening without close hole stress is 258.355 N/mm2 after closing the 2 hole 159.689 N/mm2, stress is decrease by 98.666 N/mm2.

VII. ACKNOWLEDGMENT

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